The Role of Online Communities in Vaccine Controversies

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Abstract

Vaccines play a key role in public health intervention, contributing to dramatic declines in morbidity and mortality rates. While medical knowledge delivery has been traditionally made by physicians (traditionally considered the best source of credible knowledge), patients can now widely access scientific and non-scientific information resources. There has been considerable research on knowledge delivery. However, we currently know little about healthcare knowledge delivery in online communities. In this research, we draw on material-discursive practices to conduct a qualitative study on knowledge delivery, with a focus on pro- and anti-vaccination movements. Our findings show that as knowledge delivery practices in offline settings and in online communities have different materializations, they can influence each other via their performative outcomes. We created a timeline to show important events regarding the influence of offline and online knowledge delivery practices on each other. We finally highlight the study contributions for research and practice.

Keywords: Online communities, vaccination, material-discursive practice, knowledge delivery

Introduction

Of all the branches of modern medicine, vaccinology can claim to be the one that has contributed most to the dramatic decline in morbidity and mortality rates from infectious diseases (André 2003; Kata 2012). Vaccines are considered a significant public health intervention, contributing to dramatic declines in morbidity and mortality. Nonetheless, ever since their introduction, there were skeptics who worried about the potential risks of vaccination. While questioning vaccine safety is not new, the anti-vaccine movement has been going stronger since the notion of a vaccine-autism connection has been reinforced on media and in online spaces (Kata 2012). According to Centres for Disease Control and Prevention (CDC), the second greatest measles outbreak in US happened in the first quarter of 2019. The availability of numerous scientific and non-scientific online materials on vaccine controversies, peer communications in online communities, and individual interpretations, has had a substantial effect on the decrease in the public confidence in vaccination (Larson et al. 2011). Doubting science however has some consequences. Some governments are cutting benefits for families who refuse to vaccinate their children. In some cases, non-vaccinated children cannot register at schools and day-care centres, as they are considered to put others' health at risk. To better understand knowledge delivery practices in offline and online interactions, in this study, we are examining the role of online communities in vaccine controversies.

In recent years, practices of knowledge delivery in online communities have been growing as more people are joining and sharing their experiences online (Johnson 2001). In the shift to knowledge delivery in

online communities, traditional practices of knowledge delivery are challenged as people are exposed to opposing beliefs, scientific and non-scientific evidence, and emotionally arousing stories of others (Kallinikos and Tempini 2014). The abundance of inconsistent information coupled by emotionally arousing experiences has led people to question the credibility of the knowledge provided (Kata 2012). In such communities, people increasingly challenge the way knowledge is constructed, the people who hold knowledge, and the way knowledge is being delivered (Kallinikos and Tempini 2014). Hence, studying the role of online communities to understand how they affect the established ways of knowledge delivery and to identify the consequences of such changes becomes significant.

While there has been considerable research interest in knowledge delivery and its underlying mechanisms (Baker et al. 2002), we currently know little about what happens when knowledge delivery occurs in online communities. We aim to address this gap by conducting a qualitative study in the healthcare knowledge delivery domain, more precisely in the context of vaccination. We deemed this context as appropriate and revealing for two reasons. First, the practice of knowledge delivery to patients is one of the most important aspects of health care. Healthcare professionals are continuously in the process of providing knowledge, including information about health conditions and explanations about the consequences of health decisions to their patients (Coulter and Ellins 2007). Knowledge delivery by healthcare professionals is traditionally rooted in expert knowledge, several years of field experience, and patients' medical history (Charles et al. 1999). Second, with the extensive use of online communities in recent years, patients can now easily obtain healthcare knowledge online (Kata 2012), which affects the very knowledge delivery process. Hence, healthcare provides a suitable context to study what happens when knowledge is delivered in online communities by anonymous users. A relevant case in point is vaccine knowledge delivery in online communities, which has fueled the existing controversies around vaccine administration. Known as the anti-vaccination movement, it questions the legitimacy of vaccine knowledge delivery provided by healthcare professionals (Kata 2012; Larson et al. 2011). As a small but increasing number of people refuse to vaccinate their children, several infectious diseases are spreading at higher rates and lead to higher morbidity and mortality rates from infectious diseases (André 2003; Kata 2012), as it happened with the Disneyland measles outbreak (Majumder et al. 2015).

We use material-discursive practices as our theoretical lens to study knowledge delivery practices in offline and online community environments. A material-discursive lens enables us to understand how knowledge delivery is accomplished in practice through trained professionals, written instructions, publicly accessible Internet, and online platforms. Moreover, this lens allows to focus on the constitutive entanglements of humans and technologies and study performative outcomes of knowledge delivery practices (Barad 2007). Prior work (Barad 2007) has shown that in material-discursive practices, discourse is materially expressed in bodies, things, instruments, texts, times, and places. Also, such practices can have performative outcomes reconfiguring the processes and outcomes of the organizations (Orlikowski and Scott 2013). However, our knowledge is limited regarding the influence of different material-discursive practices on each other. We argue that with new forms of technological collaboration, often there are more than one material-discursive practice at work. Different practices can produce different and sometime conflicting performative outcomes for organizations. As such, understanding the influence of different material-discursive practices on each other and on organizations becomes significant. To fill this gap, we contribute to material-discursive perspective by conducting a qualitative study on offline and online community-based knowledge delivery practices.

The move to knowledge delivery in online communities is raising important questions about how knowledge delivery practices change when they are produced in online communities by the general public and what outcomes they generate for the people who access these communities. Accordingly, we address two research questions: "How does the use of online communities change the practice of knowledge delivery to people?" and "How do offline and online communities-based knowledge delivery practices influence each other?" To answer these questions, we will investigate two notable vaccine administration positions in the public health domain: pro-vaccination and anti-vaccination knowledge delivery practices; in online communities, online government portals, and scholarly publications on vaccination. On the one hand, the pro-vaccination movement is based on medical standards, approved clinical trials, jurisdictional policies and procedures to provide vaccine administration guidelines. On the other hand, the anti-vaccination movement draws on informal, user-generated content that is typically not supported by rigorous scientific support. We use a grounded theory approach to analyze our data, which were collected from the extant literature and Facebook posts. Our research allows the identification of important

differences in the offline and online community-based knowledge delivery practices and their outcomes. As healthcare organizations are confronting the anti-vaccine movement by providing recommendations, guidelines, and policies to encourage vaccination (Betsch et al. 2012), this study aims to investigate the ongoing interaction and tension between traditional and new knowledge delivery practices. Using a material-discursive conceptualization of knowledge delivery, we aim at showing how knowledge delivery is materialized in certain ways and what its performative consequences for another apparatus are.

This study makes two contributions. First, we aim to provide a grounded understanding of the practices of knowledge delivery by empirically investigating these practices and their outcomes. We believe knowledge delivery in online communities goes beyond the expansion of the offline and standardized knowledge delivery practices, because online communities can provide equal opportunity to all perspectives and allow outlier and small extremist views the same space as scientifically approved ones (Larson et al. 2011). Second, we add to the material-discursive theory (Barad 2007; Orlikowski and Scott 2013) by showing how two different, yet related, apparatuses or material-discursive practices (i.e. offline and online communities-based knowledge delivery practices) influence each other. So far, we learned how the ongoing production of material-discursive practices or apparatuses can reconfigure processes and outcomes that are produced in organizations (Orlikowski and Scott 2013). However, we argue that in addition to reconfiguring organizational processes and outcomes, at any given time and place, an apparatus can lead to enactments in another apparatus through changing its materialization within specific activities, instruments, measures, texts, and media.

Literature Review

Knowledge delivery practices embed the sharing, transfer, accumulation, and transformation of knowledge by individuals (Beck et al. 2014). It has been studied in different contexts such as organizational learning, education, and health care. Health care is of particular relevance to our study since knowledge delivery practice to patients has a significant role in the healthcare domain (Baker et al. 2002; Jordan et al. 2010). Knowledge delivery to patients by healthcare professionals has been studied extensively from two different perspectives. One perspective focuses on healthcare professionals in improving their abilities to understand patient histories and concerns and inform patients about their conditions and treatment requirements to achieve successful diagnosis and treatment. Several studies have been conducted in this regard, looking at educational materials, patient participation, privacy and reliability concerns, cultural barriers (Coulter and Ellins 2007). From obtaining a patient's medical history to conveying a treatment plan, healthcare professional relationship with the patient is built on effective communication and education. In these encounters, both verbal and nonverbal forms of communication constitute this essential feature of medical practice (Levinson et al. 2010). Previous work has proposed different methods for informing patients such as verbal explanations, hand-written materials, printed materials, mass media, and more recently, the Internet (Coulter and Ellins 2007). As nearly all healthcare professionals use verbal explanations to deliver knowledge to their patients, there are several guidelines for this practice such as assessing of what patient already knows, providing information in a slow and deliberate fashion to allow the time needed for patients to comprehend the new information, providing short, clear, and simple explanations, telling the truth, and using appropriate body language while talking to patients (Levinson et al. 2010).

A second perspective focuses on the conflicting interests between patients and healthcare professionals. Traditionally, healthcare professionals have provided basic knowledge to patients about their illnesses and treatments. However, with time, the physician-patient relationship has moved away from a paternalistic approach, and toward focusing on shared decision making, which includes understanding a patient's medical profile and personal preferences (Fallowfield 2008). In recent years, patients' personal preferences have been influenced by several sources of online/offline medical information. A remarkable example is the anti-vaccine movement where several sources of non-scientific information about the adverse effects of vaccines have become available. As a result, some parents question the validity of physicians' knowledge by refusing to take their children for vaccination. Such movements are said to have contributed to a significant increase in the occurrence of what are preventable diseases, including measles, putting lives of many in danger (Kata 2012).

Knowledge delivery in online communities is inherently interactive and patient-driven in contrast to offline knowledge delivery practices where healthcare professionals are considered as experts and patients

trust and follow their advice (Antheunis et al. 2013). Knowledge delivery is a key factor in the life of online communities as the shared knowledge not only can benefit individuals, but also add to community's greater value (Beck et al. 2014). For example, the Mayo Clinic Center for Online communities delivers general healthcare knowledge to people via their page on Facebook. It contributes to health and well-being of patients by educating people about their health. Similarly, "Patientslikeme" is a health-related online community that enables knowledge delivery and information sharing among patients. It aims at transforming the way patients manage their own conditions, changing the way industry conducts research, and improving patient care.

There are however, potential risks in health-related knowledge delivery in online communities. For example, when individuals with vague social identities share partial information about their medical experiences, they are not always accountable for their actions (Abramson et al. 2015; Johnson 2001). The lack of availability of information for triangulation is another area of vulnerability for knowledge collaboration in online communities (Attai et al. 2015; Smailhodzic et al. 2016). While online communities provide a useful platform for knowledge delivery, they blur the line between the consumption and production of knowledge (Betsch et al. 2012; Malinen 2015). In other words, on the one hand, healthcare knowledge delivery has always been bound to standardized guidelines and approved medical trials by the scientific community. On the other hand, substantial misinformation is broadly available in online communities, which makes it difficult for patients to distinguish knowledge from misinformation (Eysenbach et al. 2004). To examine how online communities affect knowledge delivery practices, we studied, through time, vaccine knowledge delivery practices in offline and online communities.

Theoretical Underpinnings

Rooted in quantum physics and following the Bohrian approach to epistemology (Bohr 1987), "material-discursive" practices encompass a relational ontology that undermines the dualism between social and material. In this perspective, the social and the material are considered to be ontologically entangled (Orlikowski 2009). In other words, "there is no social that is not also material, and no material that is not also social" (Orlikowski 2016, p. 1437). As the material-discursive perspective removes the dualism between social and material, it enables us to provide an entirely different theorization of technology and organizations. Examples of the material-discursive practices include actor network theory (Callon and Blackwell 2007) and sociomateriality (Barad 2007).

In material-discursive perspective, the observed object (e.g. technology) and agencies of observation (i.e. apparatuses) are inseparable. The notion of apparatus refers to a specific material-discursive practice that helps constitute a phenomenon through producing knowledge about it, understanding the phenomenon, and what is potentially available for re-expression (Orlikowski and Scott 2013). Apparatuses are productive and part of the phenomenon as they enact what is included and what is excluded from the phenomenon. In other words, they enact agential cuts:

> "Given particular methods of observing, measuring or examining a phenomenon, certain properties of that phenomenon will become determinate, whereas others will be specifically excluded (Barad, 2007, p. 20). On this view, apparatuses are boundary-making practices that focus agencies of observation on one thing instead of another. Rather than regarding empirical findings as a mirror or lens through which we can see reality, findings are read through the apparatus" (Scott and Orlikowski 2009, p. 6).

Moreover, the material-discursive perspective argues for a performative practice that

> "Shifts the focus away from 'independent objects with inherent boundaries and properties' to practices, matters of doings/actions that perform particular phenomena. Phenomena, on this account, are 'ontologically primitive relations—relations without preexisting relata' that are enacted in material-discursive practices (Barad, 2003, p. 815). From such a performative perspective, technologies have no inherent properties, boundaries or meanings, but are bound up with the specific material-discursive practices that constitute certain phenomena. In contrast to the 'Cartesian cut' that enacts a determinate ontology, Barad (2003) argues for ongoing and dynamic 'agential cuts' that perform and stabilise/destabilise particular distinctions, boundaries, and properties within phenomena in practice." (Orlikowski 2009, p. 13).

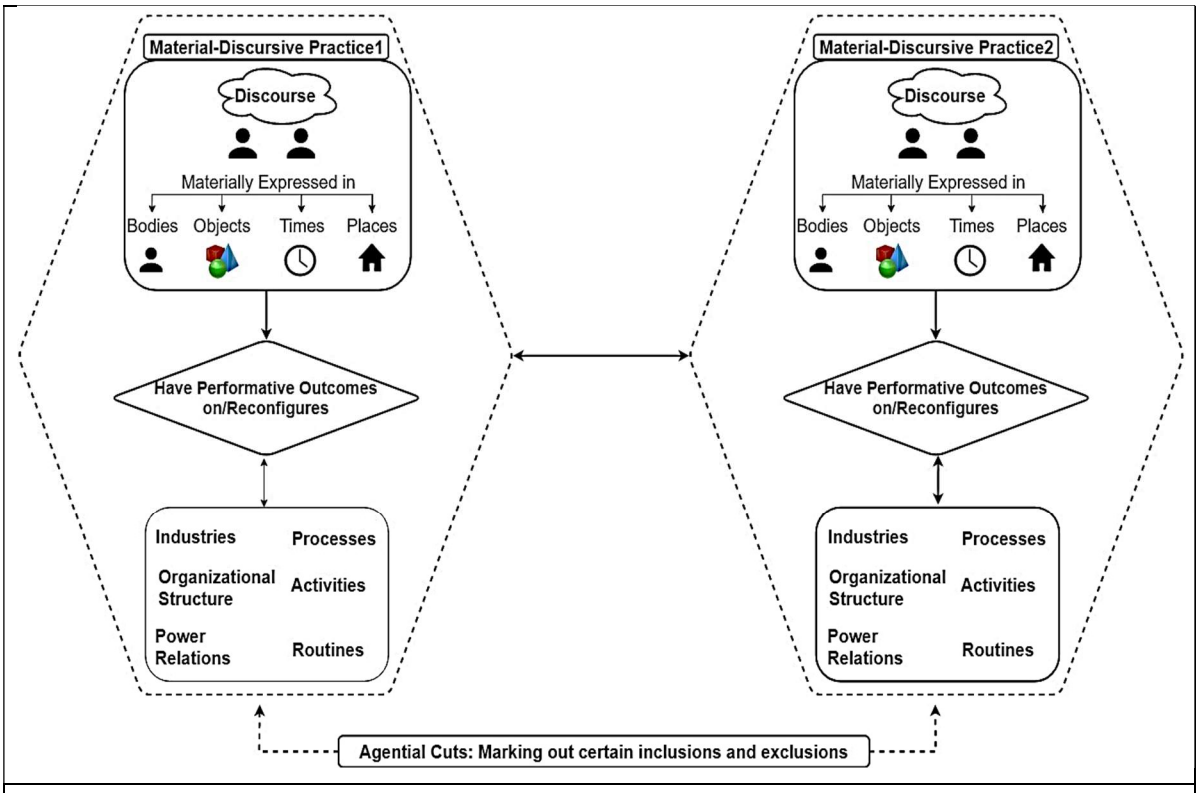

Figure 1: Material-Discursive Practices

Figure 1, provides an illustration of the material-discursive practices. As discourse is materialized in bodies, objects (e.g. texts, instructions, measurements, etc.), times, and spaces, material-discursive practices are formed. In this study, we chose to use a material-discursive perspective asbecause it removes the dualism between social and material, it offers the potential to fundamentally re-conceptualize the notion of technology and reconfigure our understanding of technology and organizations.

Moreover, we explore yet another interesting question that has remained unanswered in the material-discursive view; that is how different apparatuses influence each other. So far, extant research has focused on the entanglement of social and material and their performative outcomes. However, these studies examined different material-discursive practices in isolation (Orlikowski 2016), while in many cases, material-discursive practices are used simultaneously and are continually reconfigured.

> "This ongoing flow of agency through which "part" of the world makes itself differentially intelligible to another "part" of the world and through which local causal structures, boundaries, and properties are stabilized and destabilized does not take place in space and time, but in the making of spacetime itself are reconfigured [emphasis added], once they are configured." (Barad 2007, p. 817).

Such an understanding is a critical as it helps us to capture how performative outcomes of one practice can reconfigure local causal structures, boundaries, and properties of another practice. As material-discursive practices have performative outcomes, they can impact and reconfigure another practice through their ongoing, dynamic, relational enactments. Hence, by accounting for the intra-actions between practices, we can explain how local causal structures, boundaries, and properties are destabilized after a period of being stabilized. Our overall goal is to take a step further and add to the material-discursive practices lens by explaining how two different material-discursive practices can influence each other.

As shown in Figure 1, we propose that not only the agential cuts of knowledge delivery to patients are different in offline and online communities, but also that they influence each other via their performative

outcomes. For example, if a group of people refuse to vaccinate their children because they were influenced by the misinformation in online communities, it might happen that, in response, healthcare professionals would enact a legislation and mandate vaccine administration for every child who attends school. Next, anti-vaccine communities would start to protest against the new legislation. These influences are particularly salient with the advent of online communities. Indeed, although the anti-vaccine movement predates online communities, such communities have a significant role in disseminating the anti-vaccine views to a large group of people and enable anti-vaccine activists to interact remotely, make collective decisions, and organize several protests (Kata 2012).

Methodology

Data Collection

First, to better understand knowledge delivery practices in offline and online communities, we first collected our data on both pro and anti-vaccine movements from extant literature. Our data collection from the literature was very specific compared to the extant knowledge presented earlier in the literature review section. In our literature review, we focused on knowledge delivery practice in general. In our data collection, we focused specifically on knowledge delivery in the context ofon vaccination and searched ISI Web of Science for papers on vaccine administration. In our inclusion criteria, we considered papers in English that were published between January 2000 and May 2019. Papers that focused on vaccine knowledge delivery in offline interactions and in online communities were included in our study. Papers that focused on offline knowledge delivery to patients by healthcare professionals, nurses, and pharmacists were also included for data analysis. Moreover, papers on different types of vaccines such as MMR, Rotavirus, and Smallpox were included in our data analysis. Based on our inclusion criteria, papers that fell into the "medical issues related to vaccination development" domain, not in English, and duplicates were excluded from our analysis.

Three sets of keywords were used in combination: 1) vaccine administration (vaccination, anti-vaccination, and vaccine/anti-vaccine movement) this set resulted in 981 papers, 2) vaccine knowledge delivery (vaccine education, vaccine information) this set resulted in 551 papers, 3) vaccine in online communities (Web.20, social networking sites) this set resulted in 264 papers. Our initial search resulted in 1796 papers. Moreover, 486 duplicate papers were removed from our sample. Applying the inclusion and exclusion criteria, 1006 papers were excluded based on the title and abstract, and 266 papers were excluded based on full paper review. In total, 38 papers were included in our study.

In addition to scholarly papers, we included in our analysis publicly available vaccination guidelines from Centres for Disease Control and Prevention (CDC). CDC is the leading national public health institute of the United States and aims to protect Americans from health, safety and security threats both foreign and in the USA To accomplish its mission, it conducts scientific research and provides health information that protects people against dangerous health threats and responds when these arise ("Mission, Role and Pledge | About | CDC" 2017). We reviewed seven sections and fifty subsections of the CDC website[1] on vaccination and collected 285 pieces of information regarding vaccine knowledge delivery.

Second, we collected data on both pro and anti-vaccine movements from the posts in vaccine-related pages on Facebook to gain more insights into the knowledge that is shared in such communities. We collected data from "Dr. Tenpenny on Vaccines and Current Events" (hereafter "DT") and "Refutations to Anti-Vaccine Memes" (hereafter "RA") Facebook pages where several people communicate and publicly share knowledge on the benefits and risks of vaccines. Compared to other Facebook pages with similar scope, the DT and the RA had the highest number of subscribers (233000 and 276000 subscribers, respectively) indicating that these pages are very popular and contribute to vaccine knowledge delivery in online communities. Moreover, DT and RA are examples of extreme cases. Such cases often reveal more information about phenomena, as they are more focused on the topic and provide more details on the processes in the situation studied (Yin 2017). In addition, from both an understanding-oriented and an action-oriented perspective, it is often more important to clarify the deeper processes behind a given phenomenon and its consequences than to describe the "symptoms" of the phenomenon and how

[1] https://www.cdc.gov/

frequently they occur. Random samples emphasizing representativeness will seldom allow to produce this kind of insight (Yin 2017).

The DT online community on Facebook was created in 2009 by Dr. Tenpenny, a medical doctor regarded as the most outspoken physician on the negative impact vaccines can have on health. DT claims to deliver credible, reliable information little reported in the mainstream media, combined with practical tips for natural health and healing. The DT administrator shared content on vaccine and users participated in discussions by leaving a comment and/or reacting to another comment. On the other hand, the RA was founded in 2012 and claims to reveal the facts through text, memes, and refuting the lies and misinformation about vaccines. The RA posts sarcastic and serious memes, as well as factual articles and/or information about vaccines and their benefits. Their purpose was to debunk and refute the anti-vaccination movement with text and memes. We included the comments that were publicly shared and reflect personal views of the patients regarding the vaccination. We focused on the comments that reflect knowledge delivery practices. During May 2017 to May 2019, we initially selected 400 posts from the DT and 400 posts from the RA pages and analyzed the posts and comments related to each post that was shared by the administrators of the two pages. In DT, 103 posts were excluded because they only posed a question (62 posts) or contained content not relevant to vaccination or knowledge delivery (41 posts). In RA, 116 posts were excluded because they only posed a question (55 posts) or contained content not relevant to vaccination or knowledge delivery (61 posts). In total, 297 posts in the DT and 284 posts in the RA were included in our study. The average number of comments per post in the DT and RA were 11 and 6, respectively.

Data Collection

We followed the principles of grounded theory building (Corbin and Strauss 1990), iterating between data and literature throughout the data collection and analysis. We took an inductive approach (Patton 1990), guided by a commitment to a process that involves constant cross-checking among the different data sources, and assessing and interpreting theoretical constructs against our empirical data. Our data analysis approach was informed by our focus on knowledge delivery, material-discursive practices, and performative consequences. As this was an exploratory study, our process of data analysis was inductive and iterative, with the early stages being more open-ended than the later ones. We cycled through multiple readings of the peer reviewed papers and online community posts. In our first round of coding, we identified two vaccine knowledge delivery practices: offline and online community-based knowledge delivery practices. Although pro- and anti-vaccine movements seem to be more prominent in offline and online knowledge delivery practices, respectively, we collected and analyzed data on both pro- and anti-vaccine movements in each environment. We also collected data on the performative outcomes of each practice and on how they influence each other. We identified our coding scheme based on the elements of material-discursive practice lens. Our initial coding scheme included bodies (e.g. patients and physicians), instruments (e.g. booklets, online posters), texts (e.g. statistics, scientific, and non-scientific articles), time (e.g. before vaccination), places (e.g. physician's office), processes (e.g. vaccine exemption processes), discourse (e.g. between patients and physicians) and performative outcomes (e.g. enforcing mandatory vaccine legislations). We also remained opened to emerging codes. Two new codes emerged including instructions (e.g. guidelines) and type of discourse (e.g. formal).

Next, we reverted to the literature to help refine and structure our interpretations. We found some of the existing literature on vaccination to be particularly useful in explaining some of our observations about vaccine administration. However, the literature offered fewer insights into the activities and technologies producing the knowledge delivery practice in online communities. Also, the literature was almost not helpful in making sense of the influence of apparatuses on each other. This led us to observe the critical role of materiality in delivering knowledge, especially in online communities. To make sense of the material production of knowledge delivery in practice, we found the material-discursive practice lens to be particularly valuable (Barad 2007). Then, we compared offline and online knowledge delivery practices in terms of Barad's conceptual framing and our emerging theoretical categories, iterating and interrelating these to develop key contrasts. This process led us to articulate crucial differences in the two apparatuses of knowledge delivery, which further helped us to explain their different implications and to identify how they influence each other.

Findings

In comparing offline practices of knowledge delivery with those emerging on online communities, a number of significant discursive materializations come to light. In offline knowledge delivery practices, the main method of knowledge delivery to patients is face-to-face interactions and/or written information given to patients during a physician, pharmacist, or health worker visit. Our findings show that this practice has been reconfigured with the emergence of online communities, particularly the ones on Facebook where knowledge delivery is materialized online and intended to engage the online crowd. Comparing offline and online knowledge delivery practices not only draws attention to the making of consequential discursive materializations associated with them, but also helps us to identify critical performative outcomes that they have on each other.

Knowledge Delivery Practices in Offline Practices

Our literature analysis shows that in offline environments, face-to-face communication is used by healthcare professionals to educate patients, parents or guardians (Davis et al. 1990). Moreover, the CDC has established guidelines for physicians to communicate vaccine information to patients:

> "If a parent declines vaccines once, it does not guarantee they always will. Continue to remind parents about the importance of keeping their child up to date on vaccines during future visits and work with them to get their child caught up if they fall behind" The CDC website.

Knowledge delivery and education may be materialized in various ways. These may include oral presentations, classes, seminars, information sessions, and home outreach visits. Face-to-face communication may be undertaken on its own or combined with other interventions including telephone contact, handwritten or printed text, and multimedia material (e.g. power point presentation). Our data show that the interactive nature of face-to-face knowledge delivery means that it is a straightforward way to share information, preferences, and decisions between physicians and patients. Being in close proximity to one another, with the opportunity for eye contact and the ability to observe non-verbal reactions contribute to the physicians' ability to respond to patients' fears, correct misinformation, bring about behavior change, provide support, and respond to rumors and anti-vaccination concerns.

Our results also show that face-to-face communication can be delivered by a range of individuals including primary care physicians, nurses, lay health workers and community volunteers (Ołpiński 2012). In the USA, the Centers for Disease Control and Prevention (CDC) is recognized as the USA's premiere health promotion, prevention, and preparedness agency. Our review of the CDC website shows that it provides several immunization knowledge delivery materials, such as flyers intended to complement personal education and advice from healthcare professionals to patients. The CDC requires healthcare professionals to print and provide Vaccine Information Statements (VIS) to patients when vaccinations are administered:

> "A vaccine, like any medicine, is capable of causing serious problems, such as severe allergic reactions. The risk of the MMR vaccine causing serious harm, or death, is extremely small. Getting the MMR vaccine is much safer than getting measles, mumps or rubella. Most people who get the MMR vaccine do not have any serious problems with it." The CDC website.

Our findings indicate that since the first vaccine was developed in the 1790s, vaccination provoked fear and suspicion in people. Anti-vaccine movements were organized in the late nineteenth and early twentieth centuries in Europe and America. Anti-vaccine propaganda has materialized in posters, newspapers, word of mouth, and later on television and social media (André 2003). As a result, many parents have refused to vaccinate their children. Based on our findings, anti-vaccine group believe that vaccines contain harmful material that can cause disease such as autism (Larson et al. 2011). However, these claims are said not to have scientific support and are mainly based on anecdotes and personal views; anti-vaccine group seem to have mistrust in government and drug manufacturers, with conspiratorial thinking, denialism, reasoning flaws, and a habit of substituting emotional anecdotes for data (Ołpiński 2012). Our data show that the efforts of anti-vaccine groups have had disruptive and costly effects, including damage to individual and community well-being, from outbreaks of previously controlled diseases.

> "…management of the effects of declines in vaccine uptake, consequent disease outbreaks, and loss of public trust in the vaccines has taken a toll on human and financial resources in addition to long-term reputational costs to individual vaccines and immunization programs" (Larson et al. 2011, p. 532).

Specific protocols and guidelines have been created to protect people from anti-vaccine misinformation. Common ground might be difficult to achieve during the exchange between physicians and patients or parents due to controversies about vaccine safety. According to our findings, to counter anti-vaccine claims, the CDC offers different communication strategies to physicians for successful vaccine discourse with parents and caregivers:

> "If parents raise other possible hypotheses linking vaccines to autism, four items are key: (1) patient and empathetic reassurance that you understand that their infant's health is their top priority, and it also is your top priority, so putting children at risk of vaccine-preventable diseases without scientific evidence of a link between vaccines and autism is a risk you are not willing to take; (2) your knowledge that the onset of regressive autism symptoms often coincides with the timing of vaccines but is not caused by vaccines; (3) your personal and professional opinion that vaccines are very safe; and (4) your reminder that vaccine-preventable diseases, which may cause serious complications and even death, remain a threat." The CDC website.

Knowledge Delivery Practices in Online Communities

Based on our analysis, online communities are configured to allow interactive discourse among many users, simultaneously. Moreover, communication networks have shifted the configuration and speed of communication substantially, allowing information about vaccines and immunization to be gathered, analyzed, and used very differently compared with offline knowledge delivery practices. The amount of information in online communities has increased greatly, including scientifically valid data and evidence-based recommendations alongside poor quality data, personal opinions, and misinformation. According to our results, in online communities, there is an equal opportunity to disseminate all viewpoints, including pro- and anti-vaccine views. Allowing outlier views and small extremist opinions the same space as the views that have been validated through a rigorous peer review process by the scientific community appears to exacerbate vaccine controversies. Our analysis shows that there are three groups of actors in online communities: patients, who receive health-related information; healthcare professionals, who are pro-vaccination and deliver scientific knowledge about vaccination (e.g. the CDC); and anti-vaccination activists, who disseminate messages, facts and beliefs that oppose some or all pro-vaccination views.

Online communities are configured to include comments in a relatively unconstrained text area, which facilitates the posting of detailed content. In such communities, users can provide compelling illustrations of the points made. Both pro- and anti-vaccine groups use online communities to materialize knowledge delivery to public in various forms including emotional posts and multimedia messages. According to our findings, the most significant difference between the material enactment of vaccine knowledge delivering in offline and online communities is the relationship that is implied and the degree of diffusion afforded to different pro- and anti-vaccine groups. Unlike in the offline environment, healthcare professionals and organizations participate far less in the discourse and content sharing in online communities. Hence, the anti-vaccine groups are more salient in these online communities.

In addition to original concerns about the ease with which information is published and accessed online, the participative nature of the online communities exacerbates the transmission of rumors based on personal trust. According to our findings, the controversial information found in online communities tends to induce more skeptical views toward vaccine safety. In addition, search engines have a critical role in making online content easily accessible to the general public. Those communities that are against vaccination appear among the first lines of results when a user enter vaccine-related keywords in search engines. The increasingly interactive and social configuration of online communities makes users more exposed to anti-vaccine content. Many users can come across vaccine-related information without looking for it, through advertisement, suggestions, or tagging systems. For example, DT is currently one of the most visible and active spaces for hosting online communications on vaccine safety issues aiming to inform people about the risks of vaccines and to stop mandated vaccinations. In contrast to the RA page on Facebook and the CDC website, anti-vaccine communities are not focused on providing vaccine administration guidelines or supporting the government's public immunization program. Instead, they

mostly rely on peer contributions on vaccine safety, or lack thereof. Our data analysis shows that several online posts include not only emotional anecdotes, but also assertions that their arguments are supported by scientific evidence:

> "What makes Big Pharma any less guilty than those Nazis who put thousands to death by the Nuremberg trials? A published report acknowledged that MMR-Autism figures are completely bogus to scare the public and sell more vaccines." DT

> "Vaccine choice is a fundamental human right. No truer words. 54% of children are suffering a chronic illness or are disabled, yet we push forced vaccination like its water." DT

Our data show that comments in online communities reflect patients' own interpretations and experiences on vaccination and are sometimes narrated with candid images (Kata 2012; Larson et al. 2011). The production of this qualitative information co-exists with reactions buttons (e.g. likes, emojis), and replies from other users. These comments are then filtered by the online community algorithms to generate top comments based on the reactions of other users (Abramson et al. 2015; Johnson 2001). These algorithms can make it easier to share personal experiences and findings with a greater audience. The top comments are shown before other comments making them more visible to users. Facebook is careful not to reveal the details about its filtering algorithm, but has announced that is taking responsibility for stopping the spread of anti-vaccination misinformation on its platform (Kata 2012). Anti-vaccine claims and misinformation can be easily disseminated by these algorithms. As users do not often research the validity of the claims, they might seem less superstitious and more legitimate, scientific, and believable. Furthermore, our data analysis shows that anti-vaccine supporters have used online communities to increase their presence and dramatize cases of adverse vaccine reactions on the media (Shelby and Ernst 2013).

On the other hand, pro-vaccine online communities mostly use strategies that are utilized by anti-vaccine supporters to share information, such as sharing personal experiences, emotional content, and trying to undermine the other group's credibility. For example, they shared an interview on the life of a person affected by polio. The person was suffering from the disease and encouraged other to vaccinate. An interesting observation in our data analysis is that both pro and anti-vaccine groups claim to have scientific support for their arguments:

> "How much do I love my kids? I love my kids so much that I did not listen to the pediatrician. I love them so much that I have done real research. I love them so much that I did not vaccinated them and they are 100% healthy." DT.

> "It isn't skepticism when evidence is straight up denied. It's science denialism. Period. (FYI I was a former anti-vaccine member- but no longer). If there is a medical reason for not vaccinating, then fine - that is between you and your doctor. But medical exemptions are not the issue. People refusing to vaccinate because they don't understand science and logic is the issue." RA.

What is interesting and special about online communities and online knowledge delivery practices is that they enable people to easily access a very large amount of information on almost everything. Information overload creates confusion and controversy as people often have difficulty scrutinizing all the available data and properly distinguishing information form misinformation:

> "Looks like a case of "if you can't prove something, overwhelm everyone with too much data". There is no possible way that I could ever search through all that vaccine information, and I'd bet a pretty large sum of you haven't (and won't) either." RA.

> "Unfortunately, these first world anti-vaccine people spread their anti-science and fear throughout vulnerable populations. We had a measles outbreak a few years ago in a refugee community in the USA because they were convinced by these people that vaccines caused autism." RA.

Our analysis shows that some of the differences in offline and online knowledge delivery practices and their outcomes may be attributed to different characteristics of the knowledge delivery materials, technologies, and the people who deliver them (Kata 2012; Larson et al. 2011). However, building upon our analyses, we suggest that there is more to be learned by shifting the focus from the educational materials and people to practices (i.e. apparatuses) of knowledge delivery. Understanding knowledge

delivery as an apparatus helps us understand the particular agential cuts that make a difference to what is produced. That is, the specific observations and measurements of the apparatuses define and include some properties of a phenomenon in certain ways and exclude others. Hence, as discussed in material-discursive lens (Barad 2007; Orlikowski and Scott 2013), they make certain properties and boundaries of the knowledge being delivered determinate-in-practice. That is why in online knowledge delivery practices by CDC, the anti-vaccine views are mostly excluded and only a small number of healthcare professionals are willing to take the discussion to online communities and discuss their pro-vaccine views. On the other hand, in online anti-vaccine communities, anti-vaccine views are expressed more often than the pro-vaccine ones (Shelby and Ernst 2013). To study knowledge delivery practices as dematerialized is to ignore the large network of connected people, information, opinions, things, and experiences that actually happens. It is a critical point to consider as knowledge delivery apparatuses are consequential for the public health.

The Influence of Apparatuses on Each Other

Based on our data and literature analysis, we created a timeline to show major events related to vaccine administration and the influence of pro and anti-vaccine views on each other since the invention of the first vaccine in 1796. Table 1 provides a timeline of vaccine administration, anti-vaccine movement actions, which shows how they influenced each other (André 2003; Majumder et al. 2015; Ołpiński 2012; Poland and Jacobson 2011; Shelby and Ernst 2013).

Year	Event
1796	The first smallpox vaccine was developed by Edward Jenner in Berkeley (Gloucestershire), England.
1809	Immunizations were introduced in the USA in Massachusetts, to prevent and control smallpox outbreaks.
1850	The first school vaccination requirement was enacted in the 1850s in Massachusetts to prevent the spread of smallpox.
1893	Several schools opposed the vaccination laws. In Chicago, less than 10 percent of the children were vaccinated.
1905	The USA Supreme Court endorsed the rights of states to pass and enforce compulsory vaccination laws.
1940s-1970s	Anti-vaccine movement receded in importance. There was a significant decrease in disease outbreaks, illnesses, and deaths.
1970s	With fewer highly visible outbreaks of infectious diseases and the media permitting widespread dissemination of poor science and anecdotal claims of harm from vaccines, anti-vaccine movement began flourishing once again.
1982	A television program on DPT vaccine led to a national debate on the use of the vaccines. There were public protests. Countries that dropped routine pertussis vaccination suffered 10 to 100 times the pertussis incidence. Vaccine manufacturers faced an onslaught of lawsuits, which led the majority of them to cease vaccine production. These losses prompted the development of new programs, such as the Vaccine Injury Compensation Program (VICP), in an attempt to keep manufacturers in the USA market.
1990s	Pro and anti-vaccine movements materialized on the Internet.
1991	A measles outbreak in Philadelphia spread to more than 1,500 children and killed nine. It began in private preschools run by two churches whose 350 students had never been vaccinated.
1998	An article was published by the Lancet journal linking MMR vaccine to autism. It was retracted in 2010. This claim led to decreased use of MMR vaccine.
2004	Pro and anti-vaccine movements materialized in online communities.
2009	A US court denied the claims of more than 4000 parents of children with autism who

	claimed their children were harmed by vaccines.
2010 to present	Pro and anti-vaccine materialization in online communities. People in online communities range from vaccine believers to the ones who are simply ignorant about science to those who use deliberate mistruths, intimidation, falsified data, and threats of violence in efforts to prevent the use of vaccines.
2014	The worst multi-state measles outbreak in 50 years happened in the USA and was linked to an amusement park in California.
2019	The second worst multi-state measles outbreak in 50 years happened in the USA.

Table 1: Vaccine Timeline

As shown in Table 1, vaccine skepticism is not an entirely new phenomenon and the anti-vaccine movement formed long before the presence of online communities. In fact, ever since the introduction of vaccines, pro- and anti-vaccine movements have had multiple impacts on each other. For example, in 1893, less than 10 percent of the children were vaccinated in Chicago because several schools were against vaccine administration. Such events led the USA Supreme Court to endorse the rights of states to pass and enforce compulsory vaccination laws, in 1905.

Based on our evidence (André 2003; Majumder et al. 2015; Ołpiński 2012; Poland and Jacobson 2011; Shelby and Ernst 2013), online communities have played a significant role in disseminating the anti-vaccine views to a large group of people. They have enabled anti-vaccine activists to interact remotely, make collective decisions, and organize protests that had a key role in the USA's recent multi-state measles outbreaks. Rather than conveying the medical community instructions that are based on scientific peer reviewed research, these comments expressed the anonymous and unregulated opinions of many patients (André 2003; Majumder et al. 2015; Ołpiński 2012; Poland and Jacobson 2011; Shelby and Ernst 2013). Online communities have performative outcomes on offline knowledge delivery practices through collective actions and oppositions to policies that promote vaccination (Ołpiński 2012). With the expansion of vaccination schedules, parents might think that healthcare professionals are making fundamental decisions about their children's health without consultation or providing the option to exempt. Evidence for this is the large number of anti-vaccine groups that frequently cite this issue.

> "These bills are about money. Big Pharma can charge whatever they want for these vaccines. It's certainly not really about children or public safety." DT.

While materialization of anti-vaccine propaganda is one performative outcome of online knowledge delivery practices, losing trust in physicians and policy makers might be a more serious consequence. Indeed, many people now refuse to vaccinate their children as they lose trust in public health officials. Our data show that they accuse the public health officials of not presenting the truth about vaccination risks in order to make more money:

> "The fact that no action has been taken to get Dr. Thompson to testify makes me doubt that neither Congress nor the CDC have any interest in holding people accountable or finding out the truth. Here is a great opportunity to increase much-needed trust in vaccines and the government agencies in charge of them, but instead, they appear to hope that this story gets buried and people will forget about it." DT.

When more people lose trust in healthcare professionals and refuse to vaccinate their children, several infectious diseases spread at higher rates putting the life of many in danger, as it happened with the recent USA measles outbreak in 2019. In online communities, voices are unbalanced. In many cases, although they represent a minority, anti-vaccine proponents often become the only ones who voice their opinions, causing a sense that vaccines lead to more harm than good. Thus, publicly shared vaccine administration viewpoints in online communities have performative outcomes that not only influence offline knowledge delivery practices, but also their outcomes. Such performative outcomes of knowledge delivery in online communities, trigger enactments in the offline knowledge delivery practices in terms of activities, instruments, measures, texts, and media. In particular, the anti-vaccine movement in online communities triggered government response. Based on our analysis, the CDC and its powerful collaborators, including the Senate Judiciary Committee aim to promote public health and enforce vaccination by passing bills in different states - including California and recently New York - that would

eliminate the exemption from immunization based on personal beliefs. They require that schools do not admit children, unless they show proof of immunization against some communicable diseases. This is because most people benefit from vaccination, but never or rarely are aware of its significantly positive role due to the gradual cessation of epidemics. To create awareness, the CDC provides several educational materials on vaccine safety to the public.

> "One vaccine ingredient that has been studied specifically is thimerosal, a mercury-based preservative used to prevent contamination of multi-dose vials of vaccines. Research shows that thimerosal does not cause Autism Spectrum Disorder (ASD). In fact, a 2004 scientific review by the IOM concluded that "the evidence favors rejection of a causal relationship between thimerosal–containing vaccines and autism. Since 2003, there have been nine CDC-funded or conducted studies that have found no link between thimerosal-containing vaccines and ASD, as well as no link between the measles, mumps, and rubella (MMR) vaccine and ASD in children." The CDC website.

Our data show that government officials rarely use online communities to oppose anti-vaccine claims. They try to communicate with people through other ways including their official websites (e.g. CDC) and mass media (e.g. TV). In addition, they encourage physicians, nurses, and pharmacists to provide pro-vaccine information to people via face-to-face interactions, booklets, and written instructions. However, there are a number of pro-vaccine non-government groups in online communities such as "Refutations to Anti-Vaccine Memes" (RA) that aim to disprove anti-vaccine claims through online community posts, memes, and emotional arousing stories of other patients.

> "Radioactive waste? In vaccines? I thought I'd heard every variation of the "toxins gambit" ever peddled by antivaxers, but radioactive waste in vaccines is a new one on me!" RA.

Although both pro and anti-vaccine groups have access to online communities and offline interactions, anti-vaccine groups tend to use online communities and pro-vaccine group tend to use offline interaction as their knowledge delivery apparatuses (Kata 2012; Larson et al. 2011). As we showed in this study, different apparatuses have different performative outcomes and these outcomes can create tension between the apparatuses. For example, a performative outcome of offline knowledge delivery apparatus is the enforcement of vaccination by passing bills in different states that would eliminate the exemption from immunization based on personal beliefs. This creates limitations for people who believe getting vaccinated is a personal choice and should not be enforced. On the other hand, a performative outcome of knowledge delivery in online communities is the higher rates of non- vaccinations (Poland and Jacobson 2011). Higher rates of unvaccinated people can create vaccine-preventable diseases outbreaks and put public health at risk. Hence, government officials and physicians have to allocate additional resources to fight anti-vaccine false propaganda and increase public health safety.

Conclusion and Discussion

To date, online communities have been studied as a platform for knowledge collaboration and crowd-sourced knowledge. However, with the proliferation of knowledge and the spread of different viewpoints in online communities, come doubts. When scientific knowledge from moon landing to vaccine safety faces organized and often furious opposition empowered by non-scientific interpretations of research or misinterpretations of correlation as causality, doubters declare war on the consensus of scientific knowledge. In online communities, users often encounter contrasting sources of knowledge, which makes distinguishing knowledge form misinformation a complicated task. As a result, in the healthcare domain for example, patients face uncertainties, risks, and fears they cannot easily analyze. Drawing upon material-discursive practices, we explained how apparatuses of knowledge delivery have different performative outcomes. Using an inductive approach, we studied how offline and online community-based knowledge delivery practices have different configurations. Moreover, we uncovered how these practices influence and create tensions for each other.

From an IS perspective, we conducted our analysis to elaborate on how the particular technological configurations deployed in offline and online community-based knowledge delivery practices might influence the vaccine controversies that are played out. For instance, we explored who is able to present knowledge, what is the format of the knowledge, and how the knowledge is delivered. Through our analysis, we also considered how the nature of vaccine controversies, which predate the Internet, may

have been influenced by the particular forms of the IT involved. Shifting the focus from one material-discursive practice to multiple practices enables us to look at the phenomena in a broader view. It enables us to study how performative outcomes of one practice can reconfigure local causal structures, boundaries, and properties of another practice. Studying material-discursive practices leads us to examine knowledge delivery practices not as a series of instructions given by healthcare professionals to patients, but as materially constructed within people, things, actions, texts, spaces and times.

Knowledge delivery to patients has a significant role in the healthcare domain (Baker et al. 2002; Jordan et al. 2010). Creating knowledge delivery materials by healthcare professionals follows established guidelines to evaluate the readability and comprehensibility of the materials (Davis et al. 1990). In knowledge production for patients, quality is more important than quantity since understandable and actionable information has become recognized as an important aim of patient education materials. Patient education materials are actionable when patients with diverse backgrounds and varying levels of health literacy can identify what they can do based on the information presented (Levinson et al. 2010). Established development approaches to produce patient education materials include different steps such as reviewing existing materials to identify relevant constructs and determining the understandability of the materials. Overall, knowledge development approaches enable healthcare professionals to effectively focus on the functionality of the educational materials for patients (Davis et al. 1990).

In line with prior research (André 2003; Betsch et al. 2012; Coulter and Ellins 2007; Kata 2012), we showed that knowledge delivery practices are actively produced and the nature of knowledge delivery depends upon its materialization in bodies, things, instruments, texts, times, and places (Barad 2007; Orlikowski and Scott 2013). Understanding processes of knowledge delivery as material-discursive practices requires examining how the particular discursivity of knowledge delivery is materially expressed in practice. The specific activities, bodies, texts, and artifacts that are engaged in knowledge delivery are not merely mediators for delivering the intangible meanings or results of knowledge delivery. On the contrary, what the knowledge delivery is, at any given time and place, is what is enacted in practice through being materialized within specific forms (e.g., activities, devices, instruments, measures, texts, and media). Moreover, the specific materialization makes a difference to the kinds of knowledge delivery processes and outcomes that are produced. Knowledge delivery to patients by trusted and formally trained healthcare professionals (Coulter and Ellins 2007) will differ substantively from the knowledge that is delivered by anonymous users who anonymously share their emotional and personal experiences in online communities (Abramson et al. 2015; Johnson 2001). We showed that if knowledge delivery happens in online communities, there is necessarily a shifting in the practice as online communities provide different materialization than offline interactions. We contribute to the extant literature by showing that knowledge delivery practices in offline and online communities are configured differently, generate significantly different knowledge, and influence each other through their performative outcomes.

This study has a number of practical implications. Concerns about vaccine safety have hampered efforts at increasing immunization rates among people. The controversy and alarm caused by knowledge delivery practices in online communities is consequential and has a detrimental effect on vaccine coverage rates in society. Nowadays, individuals are very susceptible to misinformation as they spend more time in online communities than they spend in their physician's office. Yet, physicians have been relatively slow to respond to anti-vaccination propaganda in ways that are appealing to the online community audience. Putting out scientific information is not enough anymore. Healthcare professionals have to do a better job at engaging in discourse about vaccination with people in online communities. They can use different communication strategies including short messages with an informal tone, emotionally arousing or attention-grabbing text, images and videos. Efforts at developing promotive, rather than prescriptive immunization programs are likely to achieve better long-term results in a free society where trust in government and public health recommendations must be maintained.

Previous studies (Orlikowski and Scott 2013) had shown how the ongoing production of material-discursive practices or apparatuses can reconfigure the processes and outcomes of the organization. Nonetheless, IS literature had yet to explore how the performative outcomes of material-discursive practices influence one another. In this study, we took the first steps toward this goal. From a theoretical perspective, future research is needed to collect and analyze additional data that can be used to improve further our understanding of this phenomenon and make a rigorous theoretical contribution to the original material-discursive lens. Moreover, other avenues for future research from a practical side

include the need to devise better and more effective strategies for the use of online communities by pro-vaccine advocates. Mandatory programs with punitive consequences for failure to comply, as opposed to promotive immunization programs, can increase vaccine non-acceptance. To protect people against infectious diseases, pro-vaccine advocates including healthcare professionals can engage in online community discourse to advocate vaccine safety and benefits in a way that protects individual rights of autonomy and freedom of choice.

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